

Docket No.: H0498.70112US01  
(PATENT)


**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant/Appellant: Charles M. Lieber, et al.  
Serial No.: 10/812,653  
Confirmation No.: 3416  
Filed: March 29, 2004  
For: NANOSCOPIC WIRE-BASED DEVICES AND ARRAYS  
Examiner: H. Weiss  
Art Unit: 2814

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Dated: 01/12/10

Signature:  (Joan Meagher)

**REPLY BRIEF**

Mail Stop Appeal Brief - Patents  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir:

This Reply Brief is filed under 37 C.F.R. §41.41(a) and pursuant to the Examiner's Answer dated November 12, 2009.

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Appendix A. Claims as Appealed

## **I. STATUS OF CLAIMS**

The status of the claims as pending is unchanged from the Appeal Brief filed September 1, 2009.

### **A. Total Number of Claims in Application**

This application was initially filed with 89 claims (claims 1-89). There is currently one claim pending and under consideration. The status of each of the claims as initially filed is summarized below. A copy of the claim as pending is attached as Appendix A.

### **B. Current Status of Claims**

1. Claims canceled: 1-122.
2. Claims withdrawn from consideration but not canceled: None.
3. Claims pending: 123.
4. Claims allowed: None.
5. Claims rejected: 123.

### **C. Claims on Appeal**

The only claim on appeal is claim 123.

## II. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Whether claim 123 is unpatentable under 35 U.S.C. §103(a) as obvious over Melzer, *et al.*, U.S. Pat. No. 5,774,414 (“Melzner”) and Brandes, *et al.*, U.S. Pat. No. 6,445,006 (“Brandes”). These grounds are unchanged from the Appeal Brief filed September 1, 2009.

## III. ARGUMENT

A. **Claim 123 is not unpatentable over the combination of Melzner and Brandes.**

1. **The Examiner concedes that the *entire* explanation given to combine Melzner and Brandes is “to capitalize on the semiconducting properties of carbon nanotubes and their unique mechanical and electrical properties.”**

In his Answer, the Examiner states that the motivation for combining Melzner and Brandes was incorrectly stated by the Appellants as “to capitalize on the semiconducting properties of carbon nanotubes.” Instead, the Examiner indicates that the complete motivation for combining Melzner and Brandes is “to capitalize on the semiconducting properties of carbon nanotubes and their unique mechanical and electrical properties.” (Underlining indicating the Examiner’s addition, both citations omitted.)

Appellants note that despite the change in semantics, their fundamental position remains unchanged given the Examiner’s Answer: That the rejection of claim 123 should be reversed because the Examiner has not established a *prima facie* case of obviousness over the combination of Melzner and Brandes.

The Examiner indicates that the reason he has provided for combining Melzner and Brandes was copied directly from the quotation in Brandes “to capitalize on the semiconducting properties of carbon nanotubes and their unique mechanical and electrical properties.” However, the mere recitation of this single, isolated statement from Brandes, without providing the full and proper context for this sentence, does not address the Appellants’ position that the Examiner’s rationale for combining Melzner and Brandes is too vague and insufficient to support his rejection of claim 123. For example, the Examiner did not discuss any of the devices Brandes actually teaches, or what the person of ordinary skill in the art would reasonably predict could be constructed based on the teachings of Brandes. Accordingly, this rejection should be reversed.

**2. The statements from Brandes relied on by the Examiner are insufficient in specificity and guidance to provide anything more than a “hope” or a “wish” to those of ordinary skill in the art.**

In p. 4 of his Answer, in Section A, the Examiner states that Brandes teaches that “a wide variety of devices may be formed using a carbon microfiber (nanotube) as a part of the active device” (col. 7, lines 53-54). However, it should be noted that this speculative generalization literally stands in isolation within its own paragraph, as shown in the following excerpt from Brandes:

Component of Electrical Device

A wide variety of devices may be formed using a carbon microfiber (nanotube) as a part of the active device.

A point contact rectifier can be formed from a carbonnanotube produced using a catalytic growth process of the general type described in U.S. Pat. No. 5,872,422. The point contact rectifier, particularly if a small diameter carbon microfiber is used, achieves a very small capacitance, as for

example is desirable in microwave device applications. Similarly, one can use the carbonnanotube as a gate element for a MOSFET, with the advantage that the carbonnanotube can be produced with a particular dimensional character through the catalytic patterning process outlined earlier.

There is an increasing body of evidence that carbon nanotubes, if free of defects, possess a small bandgap and can be readily doped. A variety of electronic devices can be fabricated to capitalize on the semiconducting properties of carbon nanotubes, using a catalytic growth process.

FIG. 9 shows schematically representative semiconducting devices.

Brandes continues from here with a fuller description of a diode (Figs. 9A-9B) and a transistor (a MOSFET) (Fig. 10). The two underlined sentences shown in the above excerpt are the sentences that the Examiner refers to in his Answer (i.e., col. 7, lines 53-54 and col. 8, lines 1-2 of Brandes). Based on these sentences, the Examiner concludes that Brandes teaches that a carbon nanotube can be incorporated into any device, and that his rejection is “just the substitution of the nanotubes of Brandes et al. for the conductors used in Meltzer [sic] et al.” (See p. 5 of the Examiner’s Answer.)

Regarding the Examiner’s position that Brandes teaches that carbon nanotubes can be introduced into any semiconductor device, a careful reading of Brandes shows that these statements were made in the context of Brandes’s invention, and would not have provided sufficient guidance to those skilled in the art to apply the Brandes technology to all semiconductor devices with a reasonable expectation of success. Brandes teaches only certain types of electronic devices, including sensors and other devices having carbon nanotubes fixed at only one end, and does not teach or suggest a memory device, such as is taught in Melzner. The diodes and transistors as shown in Figs. 9 and 10 do not have the same

characteristics or configurations as the claimed invention, and in fact are formed from components that are not able to move, as discussed below.

Accordingly, the Examiner's characterization is broad, vague and overreaching, since the statements identified by the Examiner in Brandes are insufficient in specificity and guidance, given the state of the art at the time of the invention, to provide anything more than a hope or a research direction. One of ordinary skill in the art, in reading these statements, would have no predictability or a reasonable expectation of success in modifying Brandes as suggested by the Examiner by combining it with Melzner in order to reach the claim invention. Thus, the rejection of claim 123 should be reversed.

**3. The Examiner's reliance on conclusory statements from the Brandes reference does not support a conclusion that a carbon nanotube can be used in any electronic device without an undue degree of experimentation.**

The passage from Brandes that the Examiner points to in Part 1 of his Answer as providing the motivation to combine Melzner with Brandes is as follows (p. 5 of the Examiner's Answer, which was copied from col. 8, line 62 to col. 9, line 3 of Brandes):

The unique mechanical and electrical properties of carbon nanotubes enable a variety of novel electromechanical devices to be produced, when a suitable method of incorporating the carbon nanotube (microfiber) into the device is employed. The catalyst patterning and carbon nanotube growth process of U.S. Pat. No. 5,872,422 provides a useful approach for accomplishing this result. FIGS. 11, 12 and 13 show various illustrative microelectromechanical devices produced using carbon nanotubes.



It should be noted that this paragraph (quoted in full) appears under the heading "Component of a MEMS device," which appears just after the description of Figs. 9 and 10 in Brandes discussed in Part 2 of this Reply Brief, above.

Similar to that discussion, the above paragraph from Brandes also does not support the Examiner's conclusion that Brandes teaches that a carbon nanotube can be used in any electronic device without an undue degree of experimentation. In particular, the first sentence identified by the Examiner from Brandes merely states that a variety of novel electrochemical devices can be produced that use carbon nanotubes. But, standing in isolation, this statement is insufficient to provide a reason to the person of ordinary skill in the art to look to Melzner, or to show the operability and advantages of claimed invention would have been predictable to a person of ordinary skill in the art or achievable without undue experimentation.

Indeed, Brandes itself is directed specifically to very different types of devices—carbon nanotube sensors and other devices having carbon nanotubes fixed at only one end (see, e.g., the Appellants' Appeal Brief, p. 14-15). Thus, one of ordinary skill in the art would likely have interpreted this sentence within Brandes in a way leading to a conclusion that any of the electromechanical devices described in Brandes could be produced using carbon nanotubes with a reasonable expectation of success, not that any electrical device potentially imaginable could be produced using carbon nanotubes without an undue degree of experimentation.

The next sentence from Brandes cited by the Examiner, while stating that a certain method can be used to grow the carbon nanotubes does not teach how to apply the technique outside the context of the Brandes devices, nor would it have been predictable that very different unique and novel devices could be produced with this method. Moreover, it is not clear why techniques useful for growing a

carbon nanotube would be relevant to the claimed electrical device, and the Examiner has provided no explanation in this regard.

Finally, Figs. 11, 12 and 13, identified in the last sentence from Brandes cited by the Examiner, illustrate certain micromechanical devices that can be produced, but none of these is a memory device or a device having anything close to the configuration as presently claimed. As previously discussed in the Appellants' Appeal Brief (p. 14-15), these figures are directed to electrical devices involving carbon nanotubes that can move when subjected to an external deflecting force, where the carbon nanotubes are fixed only at one end. The relevance of such devices to the presently claimed memory device is unclear, since the claimed inventive devices do not have such a structural configuration, and the Examiner has not provided any explanation as to why advantages in the context of a sensor device would necessarily be relevant to a memory device as claimed. Accordingly, for these reasons, this rejection should be reversed.

**4. The Examiner's reasoning to support the combination of Melzner and Brandes is insufficient to support a *prima facie* case of obviousness.**

After the above quotation from Part 1 of the Examiner's Answer, the Examiner concludes that "In this case, the motivation to combine the prior art is stated, in part, in the quoted paragraph above: to take advantage of the take advantage [sic] of the unique mechanical and electrical properties of nanotubes in addition [sic]." This conclusory statement does not provide sufficient reasoning and analysis as to why or how the person of ordinary skill in the art would have or could have combined Melzner and Brandes to arrive at the claimed invention with a reasonable expectation of success, and without an undue degree of experimentation.

Moreover, in the two paragraphs immediately following, the Examiner does not provide any explanation as to how or why one of ordinary skill in the art would wish “to take advantage” of nanotubes (other than that they’re “unique”), or whether or not the advantages and functionality of the claimed invention would have been predictable to one of ordinary skill in the art attempting “to take advantage” of nanotubes, or even achievable without an undue degree of experimentation. Instead, the Examiner provides only two additional conclusory statements to support his contention: “Brandes et al. teach that nanotubes are equivalent semiconductor and electromechanical material which one of ordinary skill in the art can incorporate into any device when a suitable method is used,” and “In this case, both references are concerned with MEMS and other semiconductor devices.” (See below for further discussion of these particular issues.)

Thus, as shown above, the Examiner has stated, without providing any explanation, that the rationale for combining Brandes and Melzner is that both Brandes and Melzner are directed to semiconductor devices. However, merely stating that both are directed to semiconductor devices does not provide any articulate reasoning or rational underpinning as to why they could be combined or why the person of ordinary skill would have recognized a predictable advantage for doing so, which is necessary to support the legal conclusion of obviousness. While the Examiner recites portions of the M.P.E.P. as providing bases for the rejection, that does not relieve the Examiner from his burden of providing *explicit* reasoning and analysis that is amenable to review (“[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some *articulated reasoning with some rational underpinning* to support the legal conclusion of obviousness,” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398 (2007),

quoting *In re Kahn*, 441 F.3d 977 (Fed. Cir. 2006) (Emphasis added)). In this case, the few sentences quoted above—in full—appear to form the *entire* basis upon which the Examiner maintains that the person of ordinary skill would have found it obvious to modify and adapt Brandes to apply the nanowire technology of Brandes to essentially any and all semiconductor devices. Such an “obvious to try” rationale is not appropriate where, as here, the possibilities are nearly limitless and the degree of unpredictability is high.<sup>1</sup> Such a vague, open-ended, speculative rationale is wholly inadequate to provide articulate reasoning as to why one of ordinary skill in the art would have selected Melzner and Brandes from a sea of prior art, and combined them together in a manner to arrive at the claimed invention. Accordingly, for this additional reason, the rejection of claim 123 in view of Melzner and Brandes is improper, and should be reversed.

**5. For the first time, the Examiner responds to the Appellants’ position that the combination of Melzner and Brandes would not have enabled practice of the invention as claimed at the time the invention was made without undue experimentation, and does not provide sufficient support for his position that it would have.**

On p. 7 of his Answer, in Part 2, the Examiner suggests that by modifying Brandes and Melzner in specific ways, one of ordinary skill in the art would have

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<sup>1</sup> Indeed, the number of references that recite a “semiconductor device” likely numbers in the *millions*. To wit, a search of Google Scholar at <http://scholar.google.com/> conducted on December 18, 2009 for just the term “semiconductor device” produced about 1,140,000 references, while a search of the USPTO website at <http://patft.uspto.gov/> produced 109,341 patents and 92,078 pending applications. Even without specific numbers, the Board can take Judicial Notice that the semiconductor device industry is an established, well-developed field that has produced numerous patents and other references. For example, the U.S. Patent Office has several Art Units devoted to various aspects of semiconductor devices, including but not limited to Art Units 2811, 2812, 2814 (where the preset application was assigned), 2816, 2817, 2819, etc.

been able to arrive at the claimed invention, thus finally responding to the Appellants' position that the combination of Melzner and Brandes could not be achieved by the person of ordinary skill without undue experimentation. For example, the Examiner speculates that:

The diaphragm in the device of Melzner et al. can be duplicated, for example, using bunched or bundles of nanotubes. In this way, the stresses encountered would be compensated by the added nanotubes but would remain flexible enough to work in the memory of Melzner et al.

Although some variations and modifications when combining references are permissible, the Examiner still cannot engage in hindsight reasoning in his analysis; instead, the Examiner must provide an articulate reason with some rational underpinning based upon the knowledge and skill set of the person of ordinary skill in the art at the time of Appellants' invention to support his analysis. Here, the Examiner has provided no explanation as to why one of ordinary skill in the art would have had a reason to shrink the device of Melzner to nanotube dimensions, nor why one of ordinary skill in the art would have wanted to replace the diaphragm of Melzner with bunches or bundles of nanotubes. The Examiner has provided no reference that teaches how a bunch or a bundle of nanotubes could even have been produced at the time of Appellants' invention (Brandes nowhere teaches or suggests a bunch or bundle of nanotubes), nor has the Examiner provided a reference that teaches how such a bundle of nanotubes could have been assembled as part of an electrical device by the person of ordinary skill with a reasonable expectation of success. The Examiner has provided no explanation of how the shape of a bundle of carbon nanotubes could approximate the shape of a concave or convex circular diaphragm. The Examiner has provided no discussion

of why he believes that the physical properties (in particular, the stress profile) of a bundle of carbon nanotubes would be similar to the physical properties of a concave or convex circular diaphragm. At best, the Examiner only suggests that the *figures* of Brandes illustrate the flexibility of the nanotubes. Appellants are puzzled as to how one would be able to determine the mechanical flexibility of a carbon nanotube *only* from a pictorial line drawing of a carbon nanotube, or why a drawing of a carbon nanotube that is fixed at only one end would provide any insight as to the mechanical flexibility of a carbon nanotube fixed at both ends.

The Examiner also suggests, for the first time, that Figs. 9 and 10 of Brandes show crossed nanotubes having fixed ends. But the nanotubes in Figs. 9 and 10 are *unable* to move. See, e.g., col. 8, lines 5-60 of Brandes, describing these devices. In particular, Fig. 9 illustrates a junction device formed by crossing two nanotubes together ("The tubes of different conductivity type are made to cross and the device junction is formed where they are in contact," col. 8, lines 45-47). There is no disclosure or suggestion in Brandes of these tubes being able to move after formation; in fact, any movement would destroy the junction thereby formed when the tubes are in contact each other—defeating the intended purpose of forming the junction device. Similarly, Fig. 10 illustrates a transistor device having a gate, source, and drain electrodes. As with the crossed junction, a transistor in which parts of it were able to move around would not be able to function properly, and nowhere is it taught or suggested in Brandes that the nanotubes in Fig. 10 are able to move. Accordingly, although the Examiner now introduces Figs. 9 and 10 for the first time in his Answer, this regardless does not change the Appellants' view that Brandes could not have been combined with Melzner by the person of ordinary skill in the art to form a functional device within the scope of the

presently claimed invention without an undue degree of experimentation. For this additional reason, the rejection of claim 123 should be reversed.

**6. The combination of Melzner and Brandes, even if these references could be combined, still does not reach the claimed invention.**

The Examiner appears to have misconstrued the Appellants' argument that the proposed combination of Melzner and Brandes would not be functional with an admission or suggestion that the presently claimed invention is not functional or enabled. However, the presently claimed invention as disclosed in Appellants' specification is not described as a combination of Melzner and Brandes. Thus, there is no actual inconsistency in the Appellants' argument that while the presently claimed invention is fully enabled and not non-functional, the proposed combination of Melzner and Brandes would be non-functional.

Melzner discloses semiconductor memory devices where a plurality of memory cells are constructed using a micromechanical diaphragm (a circular disc) placed under compressive stress such that it is in either a "concave up" or a "concave down" state. An electrical connection is made with a lower "sharp point" when a circular diaphragm is in a "concave up" position but not when it is in the "concave down" position. Since a large circular disc is used, the alignment of the lower "sharp point" with the surface of the circular diaphragm need not be exact or precise; as long as the "sharp point" contacts the circular diaphragm somewhere within the circular diaphragm (not necessarily at its exact center), a connection is made and the corresponding memory state for that circular diaphragm can be determined.

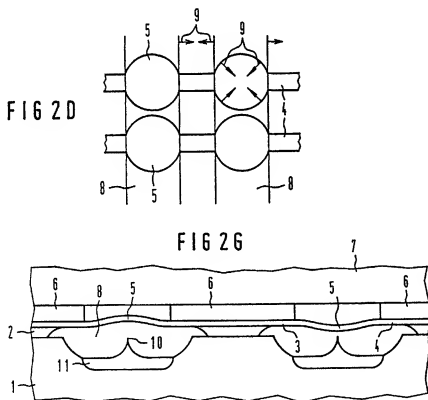
In contrast, while Brandes teaches a carbon nanotube that can be fixed at one end which could be used as a “sharp point,” nowhere does Brandes disclose or suggest a carbon nanotube or other structure having a shape that could be substituted for the circular diaphragm of Melzner. To the contrary, Brandes only teaches carbon nanotubes, and does not suggest applications such as the memory device disclosed in Melzner; indeed, Brandes nowhere discloses or suggests a memory device at all.

The modification now proposed by the Examiner, as understood by the Appellants, i.e., substituting a bunch or bundle of nanotubes in place of the circular diaphragm does not indicate how or why it would have been expected that the bunch or bundle of nanotubes would have mechanical properties enabling to perform the function of the Melzner diaphragm and, furthermore, still fails to solve the alignment issue. If the “sharp point” of the proposed device is not precisely aligned so as to make actual contact with at least one nanotube of the bunch or bundle of nanotubes, then no connection would be made, regardless of the position of the bunch or bundle of carbon nanotubes, accordingly rendering that memory element useless. Thus, the substitution of the carbon nanotubes of Brandes for the circular diaphragms in the memory device of Melzner, without more, would have lead to the predication by those skilled in the art that many of the nanotube devices would fail subverting any reason to attempt such a modification.

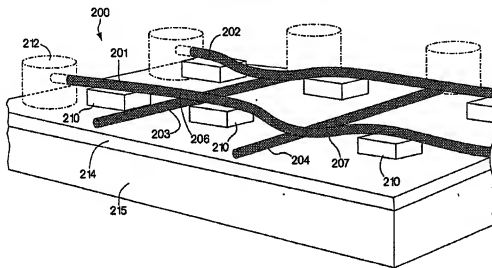
In stark contrast, the present invention does not require either the “sharp point” or the “circular diaphragm” elements required in Melzner in order to function. Thus, the present invention is not merely a combination of Melzner and Brandes, and accordingly, the argument that the combination of Melzner and Brandes would not be functional should not be understood to be an admission that the claimed invention is not functional.



In fact, in the present invention, as discussed in the Appellant's Appeal Brief on pages 5-7 (referencing Fig. 8 of the instant application), the disclosed configuration with a nanowire crossing a conductor assures contact due to their crossing geometry. No "sharp points" or "circular diaphragms" are used to produce an electrical connection. Instead, the wire is attracted to the conductor, both oriented longitudinally, through electrical attraction, and precise alignment is not required. See Figs. 2D and 2G of Melzner (below), which are top and side views, respectively, illustrating the circular diaphragms (5) and the sharp points (10) of the memory devices in Melzner. In particular, in the right memory element of Fig. 2G, contact has been made between circular diaphragm 5 and sharp point 10:



In contrast, the presently claimed invention eliminates the need for both the “sharp point” and the “circular diaphragm” elements, as is shown in Fig. 8 of instant application:



**Fig. 8**

Instead, contact is made because the conductive elements from a crossing array, and geometrically, wires arrayed longitudinally as shown in Fig. 8 (instead of vertically as shown in Melzner) must cross at some point.

Accordingly, the proposed combination of Melzner and Brandes, to the extent these references could or would have been combined, still would not result in the claimed invention. Thus, for this additional reason, the rejection of claim 123 should be withdrawn.

#### **IV. CONCLUSION**

For the foregoing reasons, the rejection of claim 123 was improper, and should be reversed.

Dated: 01/12/10

Respectfully submitted,

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**APPENDIX A. CLAIMS AS APPEALED**

1-122. (Cancelled)

123. (Previously Presented) An article, comprising:

an electrical crossbar array defined by a plurality of conductors and a plurality of nanotubes which cross the plurality of conductors at intersections, wherein a plurality of the intersections are unique data storage elements and are switched between at least “on” and “off” readable states by solely applying dissimilar or similar electrical potential to one or more of the conductors and one or more of the nanotubes that define the unique data storage elements, whereby for each of said elements, the one or more nanotubes deforms and electrically connects, or disconnects, respectively, to the one or more conductors to switch the unique data storage element to the “on” or “off” state, respectively, upon the application of the dissimilar or similar electrical potential, and whereby when switched to the “on” or “off” state, the unique data storage element remains in said state absent application of a similar, or dissimilar electrical potential, respectively, to the one or more conductors and the one or more nanotubes defining the unique data storage element, but when a similar, or dissimilar electrical potential, respectively, is applied between the one or more conductors and the one or more nanotubes defining the unique data storage element, the unique data storage element returns to an “off” or “on” state, respectively.